

Engineering the Nonlethal Artillery Projectile

By Stephen G. Floroff



As Field Artillery evolves to meet the challenges of future wars against terrorism, the tactical concept of nonlethal fires will undoubtedly gain increasing emphasis. By generating nonlethal protective and suppressive fires as well as special-purpose fires (incapacitants, countermobility and thermobaric effects), the FA will be poised to participate in all aspects of the future spectrum of conflict.

For the first time, the potential exists for both general support (GS) and direct support (DS) artillery units to engage in non-combat scenarios, providing large standoff, nonlethal indirect fires in support of maneuver forces. Nonlethal payloads are being contemplated to control crowds, disable vehicle mobility, provide networked detection and sensing, as well as disrupt radar and communications and electrical power. To achieve these goals, we must re-think the entire munitions delivery concept, emphasizing non-destructive payload delivery mechanisms.

Department of Defense Directive 3000.3, Policy for Non-Lethal Weapons defines them as those that “are explicitly designed and primarily employed so as to incapacitate personnel or material, while *minimizing* fatalities, permanent injury to personnel and undesired damage to property and the environment”[emphasis added].

These seemingly disparate requirements pose unique engineering challenges for the munitions community that, up until now, has concentrated on maximizing destructive terminal effects. The goal now becomes to create a nonlethal carrier or payload delivery mechanism to minimize, as opposed to maximize, collateral damage within a defined target area. The unique challenges associated with achieving this goal form the basis of this article.

Within the nonlethal community, it is generally accepted that any impact exceeding 58 foot-pounds of kinetic en-

ergy will result in a potential fatality. To put this metric into real-world perspective, 58 foot-pounds equates to roughly one-half the impact one would feel being hit by a baseball thrown by a professional pitcher.

How can this metric realistically be evaluated in an indirect fire scenario? One simple and comparatively inexpensive approach is to employ a mortar as a “first cut” tool to evaluate potential nonlethal collateral damage terminal effects.

In September 2000, engineers at the Tank-Automotive and Armaments Command-Armaments Research, Development and Engineer Center (TACOM-ARDEC), Picatinny Arsenal, New Jersey, initiated a program to develop a nonlethal 81-mm mortar munition or “cartridge” using non-traditional materials. The purpose was to develop a cartridge that impacts with nonlethal kinetic energy as described. (See Figure 1 for the cartridge design goals and the technical challenges associated with them.)

Design Goals

- Minimize mechanical and deployment complexity.
- Minimize negative impact to payload volume.
- Require no special handling, storage or training.
- Be scalable to artillery projectile and missile applications.

Technical Challenges

- Survive typical muzzle-launch environments.
- Have appropriate fuzing for optimum payload dispersal and effect.
- Require accurate meteorological data at the *target* location—
 - To compute payload dispersal and effect.
 - To ensure kinetic energy criteria is met.

Figure 1: The Design Goals and Technical Challenges Associated with Developing a Nonlethal Mortar Cartridge

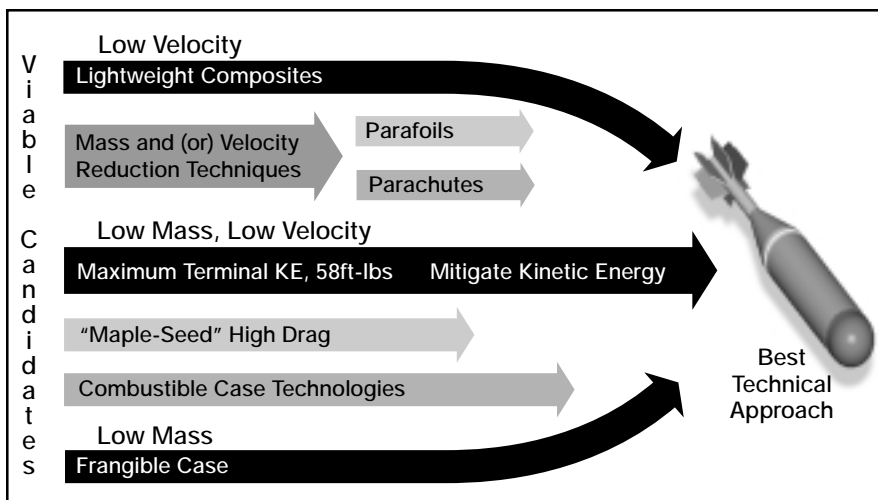


Figure 2: Process to Reduce the Kinetic Energy of a Nonlethal Mortar Cartridge

Many conceptual approaches to reduce the kinetic energy impact of the mortar cartridge are being investigated. Because kinetic energy is mass- and velocity-dependent, minimizing these constituents, either independently or to-

gether, will produce the best technical approach for continued development. This process is shown in Figure 2.

Current considerations include the introduction of "non-traditional" cartridge materials, such as frangible and organic

composites, as well as a completely combustible cartridge case that burns up after dispensing a nonlethal payload over the target area. ("Frangible" means the shell casing will break into small, lightweight pieces before or upon impact.)

More radical approaches to reducing kinetic energy impact include deployable rotors to induce a "winged maple-seed" effect (Figure 3) and the more traditional parachute (Figure 4) to reduce impact velocity. Both of these concepts have advantages and disadvantages and both will be screened against "exit criteria" to rank their relative effectiveness. (See Figure 5.)

While the mortar presents a cost-effective method to evaluate methodologies for delivering nonlethal indirect fire payloads, the technology associated with kinetic energy mitigation is directly applicable to nonlethal payloads for cannons or missiles. One possible approach to a cannon-launched

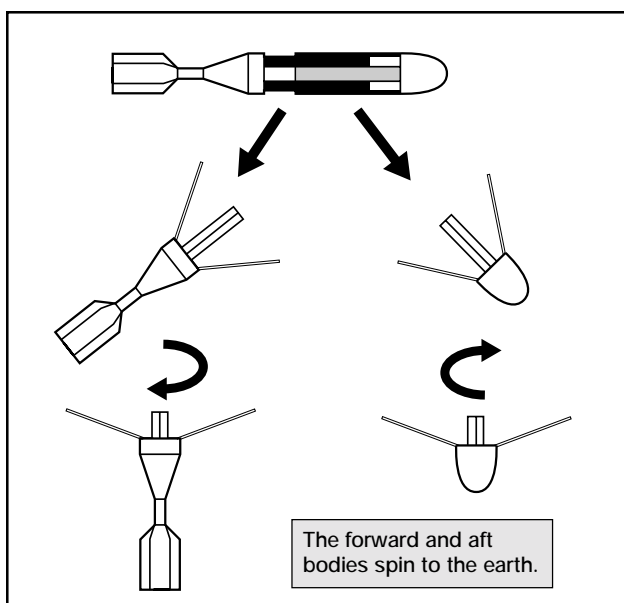


Figure 3: Double-Vane Decelerator. To reduce kinetic energy, the mortar cartridge could deploy rotors to induce the "winged maple seed" effect.

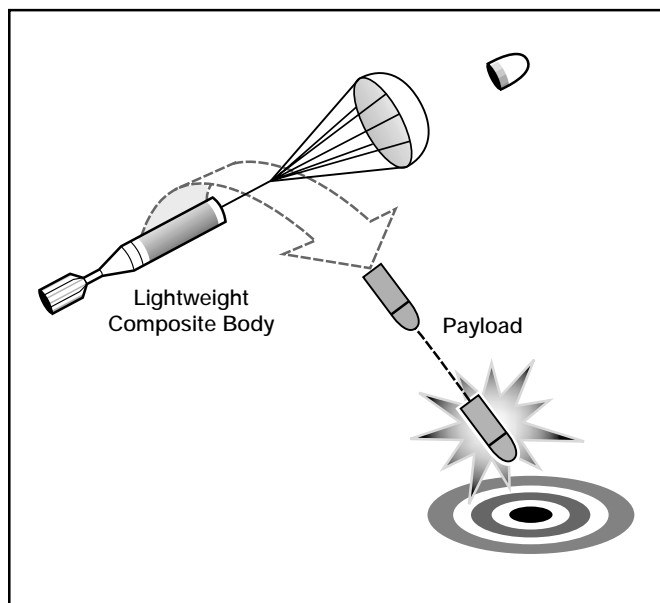


Figure 4: Single Parachute Forward Ejection Cartridge. This is a more traditional approach to reducing the impact velocity of a cartridge. This cartridge would have a fuze in the rear.

Criterion	Threshold	Objective
1. Survive Muzzle Launch Environment	Successful Launch from 200 to 2,500 Meters	150 to 4,000 Meters
2. Projectile Accuracy using Lightweight Nonlethal Casing	Delivery Accuracy to 1 Probable Error (PE) <15 Meters to 1,500 Meters	<1% of Impact Range Beyond 1,500 Meters
3. Fuzing Concept for Optimum Payload Dispersal and Effect	Successful Nonlethal Delivery and Dispense of Generic Payloads Over the Area	
4. Maximum Terminal Kinetic Energy	58 Foot-Pounds	25 Foot-Pounds
5. Scalable Technology		

Figure 5: "Exit Criteria" for the Nonlethal Mortar Cartridge Development Program

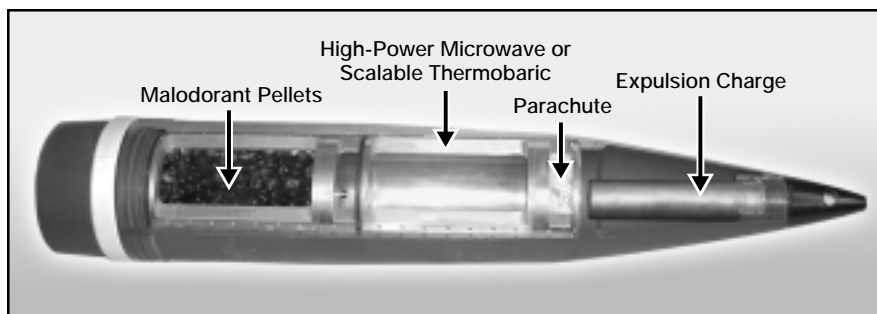


Figure 6: Potential Nonlethal Artillery Shell. This would be a 155-mm improved conventional munition (ICM), requiring no additional crew training to load or fire the round.

nonlethal artillery shell is shown in Figure 6.

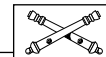
Using a conventional 155-mm improved conventional munition (ICM) round as a carrier, no additional or specialized crew training would be required to load and fire it. Once the round was over a target area, it could eject two cartridges containing various nonlethal payloads. Conceptually, the cartridges could contain malodorant pellets for crowd control and (or) thermobaric or high-power microwave payloads for more specialized mission scenarios.

Nonlethal indirect fire munitions present a unique opportunity for the FA to move into more nontraditional fire missions. The engineering associated with creating and employing these munitions in an indirect fire role is still in

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its infancy; however, we understand and are working the technical challenges. We are building and testing prototypes.

What remains is to create and maintain a dialog within the FA community as to the potential and relevance for nonlethal indirect "fires" in the future spectrum of conflict.



Stephen G. Floroff is a Senior Artillery Engineer employed at TACOM-ARDEC at Picatinny Arsenal. During his 24-year federal career, he has been involved exclusively in research and development activities associated with future artillery development. He has been responsible for many artillery weapon prototypes demonstrating robotic ammunition handling, novel recoil attenuation techniques, towed artillery digitization, lightweight howitzer design and, most recently, nonlethal indirect fire initiatives. He has published many technical reports on artillery-related research and development topics and has spoken at national and international weapons and munitions symposia. He holds a Bachelor of Science in Mechanical Engineering from the New Jersey Institute of Technology.

Branch-Mix CCC: Making a Good Program Even Better

In the Army's "branch-mix" program, senior first lieutenants and junior captains attend a sister combat arms branch's captain's career course (CCC) in lieu of their own. This program develops junior leaders to better function in the combined arms environment.

In the case of Field Artillerymen participating in the program, adding a distance learning module would improve Redleg skills while increasing their understanding of the combined arms team—making a good program even better.

The FACCC mission is to prepare officers to become battalion and brigade staff officers, fire direction officers (FDOs), task force fire support officers (FSOs) and battery commanders. Students undertake a rigorous 20-week course in gunnery, communications and fire direction systems in a large group followed by small group instruction (12 to 18 students) focusing on tactics, fire support and leadership instruction.

Branch-mix CCCs place FA officers in small group seminars to diversify the course. In these groups, Redlegs improve relations with other combat arms branches and increase their understanding of the combined arms team.

The branch-mix program provides a forum for Infantry, Armor, Air Defense, Engineer and Aviation officers to teach future artillery commanders and fire supporters. Understanding the supported combined arms tactics and procedures enables artillery officers to plan more effective fires and place munitions where and when maneuver commanders need them most. Artillery officers, in turn, educate future combined arms commanders about FA capabilities.

Although FA officers learn a great deal about other branch tactics, techniques and procedures (TTPs) in this program, the lack of gunnery and fire support reviews introduces a sharper learning curve for branch-mix CCC graduates expected to have the latest knowledge of FA TTPs.

Furthermore, branch-mix officers have had less contact with their artillery peers. Career course students benefit from sharing varied experiences, particularly in the FACCC due to the large amount of technical diversity in the branch. For example, those at the FACCC unfamiliar with the advanced Field Artillery tactical data system (AFATDS) learn the textbook directions as well as common

mistakes from experienced FACCC students.

One solution to the disadvantages of the branch-mix program would be distance learning module(s) for FA officers attending another branch's career course. By way of example, Marine officers complete correspondence course work for the Marine Amphibious Warfare School before attending an Army career course. By completing the FACCC through correspondence, artillery captains would learn the most important skills taught in the FA career course as well as gain a better understanding of the combined arms system.

Fighting to win the nation's wars requires accurate, responsive fires provided by officers who have a broad understanding of the combined arms team. Adding an FA distance learning module to the current branch-mix CCC requirements for FA officers will increase the artilleryman's ability to provide these fires and improve his overall career course experience.

CPT Kevin J. Terrazas, FA
Recent Student, Infantry CCC
Fort Benning, GA